GROUNDWATER MONITORING

Groundwater Monitoring Program Overview

Groundwater at the West Valley Demonstration Project (WVDP) is monitored according to a comprehensive program developed to comply with all applicable state and federal regulations. The monitoring program also meets requirements of Department of Energy (DOE) Order 5400.1 to obtain data for determining baseline conditions of groundwater quality and quantity, to provide data that will allow the early detection of groundwater contamination, to identify existing and potential groundwater contamination sources and maintain surveillance of these sources, and to provide data upon which decisions can be made concerning the integrity of existing disposal areas and the management and protection of groundwater resources.

Current groundwater monitoring activities at the WVDP are summarized in two primary documents – the Groundwater Monitoring Plan (West Valley Nuclear Services Co., September 27, 2001) and the Groundwater Protection Management Program Plan (West Valley Nuclear Services Co., May 2, 2000). The Groundwater Monitoring Plan outlines the WVDP's plans for groundwater characterization, current groundwater sampling requirements, and support of long-term monitoring requirements identified in the Resource Conservation and Recovery Act (RCRA) facilities investigation (RFI) and DOE programs. The Groundwater Protection Management Program Plan provides additional information regarding protection of groundwater from on-site activities.

Geologic History of the West Valley Site

The Western New York Nuclear Service Center (WNYNSC) comprises approximately 3,345 acres (1,354 ha) and is located on the Allegheny Plateau near the northern border of Cattaraugus County in Western New York. The 200-acre (80-ha) WVDP site is located on the WNYNSC. Beneath the WNYNSC site is a sequence of Holocene (recent age) and Pleistocene (ice age) sediments filling a steep-sided valley incised in the bedrock. The bedrock is composed of shales and interbedded siltstones of the upper Devonian Canadaway and Conneaut Groups that dip southward at about 5 m/km (Rickard, 1975).

The Pleistocene sediments overlying the bedrock typically consist of a sequence of three glacial tills of Lavery, Kent, and possibly Olean age. The tills are separated by stratified fluvio-lacustrine deposits. In the northern part of the site the Lavery till is capped by coarse-grained alluvial-fluvial deposits.

Repeated glaciations of the ancestral bedrock valley occurred between 24,000 and 15,000 years ago (Albanese et al., 1984), ending with the deposition of up to 130 feet (40 m) of Lavery till. Post-Lavery outwash and alluvial fans, including the sand and gravel unit that covers the northern portion of the WVDP site, were deposited on the Lavery till between 15,000 and 14,200 years ago (LaFleur, 1979).

A summary of the site hydrology is presented below. Hydrologic conditions of the site are more fully described in Environmental Information Document, Volume III: Hydrology, Part 4 (West Valley Nuclear Services Co., Inc., March 1996) and in the RCRA Facility Investigation Report: Introduction and General Site Overview (West Valley Nuclear Services Co., Inc., July 1997).

Surface Water Hydrology of the West Valley Site

The WNYNSC lies within the Cattaraugus Creek watershed, which empties into Lake Erie about 27 miles (43 km) southwest of Buffalo. Buttermilk Creek, a tributary of Cattaraugus Creek, drains most of the WNYNSC and all of the WVDP site.

The WVDP site, located on the WNYNSC, is contained within the smaller Frank's Creek watershed. Frank's Creek, a tributary of Buttermilk Creek, forms the eastern and southern boundary of the WVDP; Quarry Creek, a tributary of Frank's Creek, forms the northern boundary. (See Fig. A-1 [p. A-3].)

Another tributary of Frank's Creek, Erdman Brook, bisects the WVDP into a north and south plateau. The main plant, waste tanks, and lagoons are located on the north plateau. The drum cell, the U.S. Nuclear Regulatory Commission (NRC)-licensed disposal area (NDA), and the New York State-licensed disposal area (SDA) are located on the south plateau.

Hydrogeology of the West Valley Site

The WVDP site area is underlain by a sequence of glacial tills comprised primarily of clays and silts separated by coarser-grained interstadial sediments. Because the bottommost layer, the Kent till, is less permeable than the other geological units and does not provide a pathway for contaminant movement from the WVDP, it is not discussed here.

The sediments above the Kent till – the Kent recessional sequence, the Lavery till and the intra-Lavery till-sand, and the surficial sand and gravel – are generally regarded as containing all of the potential routes for the migration of contaminants (via groundwater) from the WVDP site. (Figs. 3-1 and 3-2 [*facing page*] show the relative locations of these sediments on the north and south plateaus.) The Lavery till, the Kent recessional sequence, and the Kent till are common to both the north and south plateaus.

Kent Recessional Sequence. The Kent recessional sequence consists of a fine-grained lacustrine unit of interbedded clay and silty clay layers locally overlain by coarse-grained glacial sands and gravels. These deposits underlie the Lavery till beneath most of the site, pinching out along the southwestern margin of the site where the walls of the bedrock valley intersect the sequence.

Groundwater flow in the Kent recessional sequence is predominantly to the northeast, toward Buttermilk Creek. Hydraulic conductivity testing completed during the last several years indicates a mean value of 2E-01 ft/day (8E-05 cm/sec) or 2.6 in/day. Recharge comes from the overlying Lavery till and in flow from the bedrock in the southwest, and discharge is to Buttermilk Creek.

Lavery Till. The Lavery till is predominantly an olive-gray, silty clay glacial till with scattered lenses

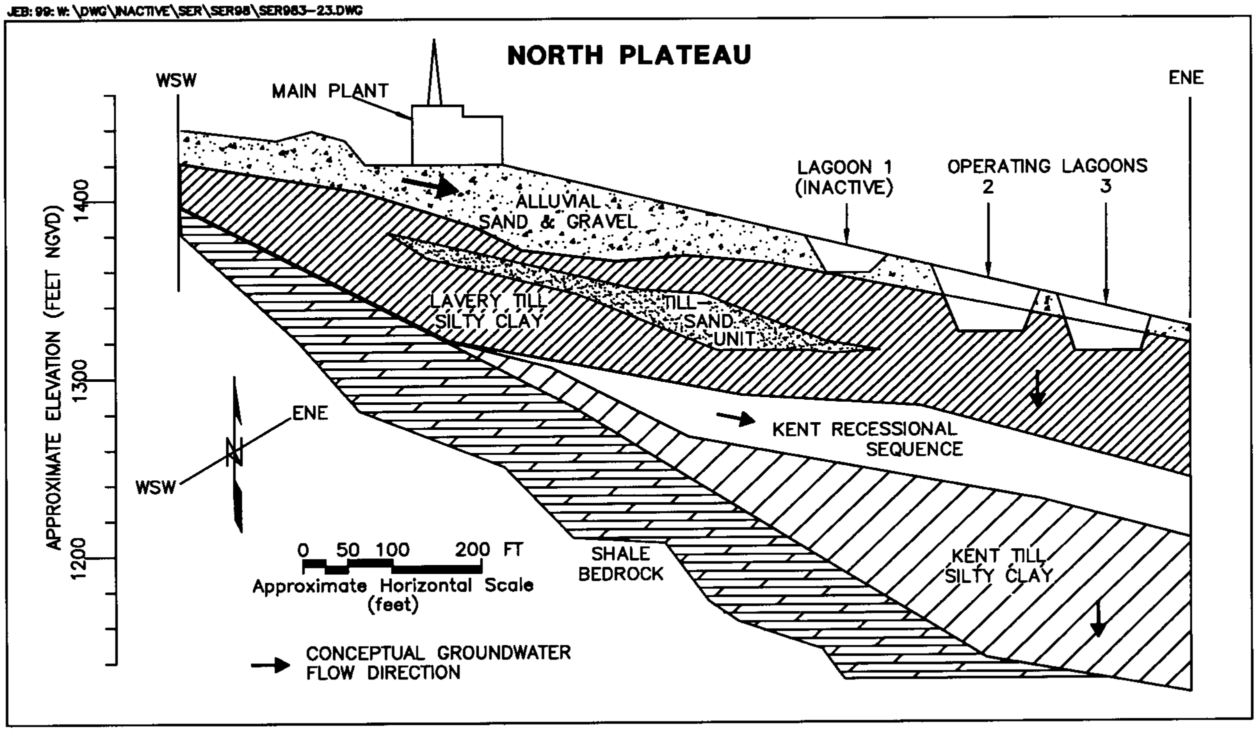

Figure 3-1. Geologic Cross Section Through the North Plateau (Vertical Exaggeration Approx. 2:1)

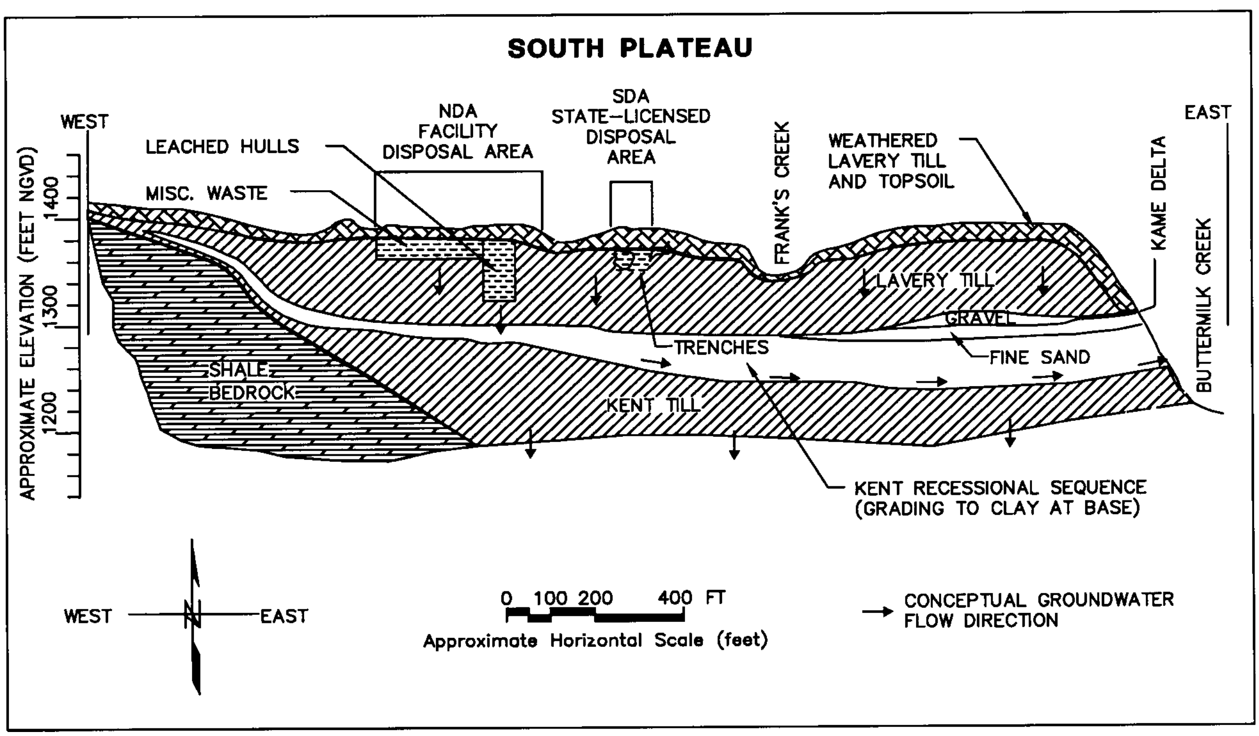

Figure 3-2. Geologic Cross Section Through the South Plateau (Vertical Exaggeration Approx. 2.5:1)

of silt and sand. It underlies both the north and south plateaus and ranges up to 130 feet (40 m) in thickness beneath the active areas of the site, slightly increasing northeastward towards Buttermilk Creek and the center of the bedrock valley.

Hydraulic head distributions in the unweathered Lavery till indicate that groundwater flow is predominantly vertically downward at a relatively slow rate, toward the underlying Kent recessional sequence. Hydraulic conductivity testing in the Lavery till during the last several years indicates a mean value of 1E-04 ft/day (1E-07 cm/sec) or 0.001 in/day. Some wells have produced hydraulic conductivity values as high as 3E-04 cm/s, which may indicate the presence of sand lenses within the till.

On the south plateau, the upper zone of the Lavery till is exposed at the ground surface and is weathered and fractured to a depth of 3 to 16 feet (0.9 to 4.9 m). This layer is referred to as the *weathered Lavery till* and is unique to the south plateau. The weathered Lavery till has been oxidized to a brown color and contains numerous dessication cracks and root tubes.

Groundwater flow in the weathered till has both horizontal and vertical components. This enables the groundwater to move laterally across the south plateau before moving downward into the unweathered Lavery till or discharging to nearby incised stream channels. Hydraulic conductivity testing in the weathered Lavery till completed during the last several years indicates a mean value of 5E-02 ft/day (2E-05 cm/sec) or 0.6 in/day. The highest conductivities are associated with the dense fracture zones found within the upper 7 feet (2 m) of the unit.

On the north plateau, where the main plant, waste tanks, and lagoons are located, the weathered till layer is much thinner or nonexistent and the unweathered Lavery till is immediately overlain by the sand and gravel unit.

Sand and Gravel and Till-Sand Units. The *sand and gravel unit* and the *Lavery till-sand* are unique to the north plateau. The sand and gravel unit is a silty sand and gravel layer composed of younger Holocene alluvial deposits that overlie older Pleistocene-age glaciofluvial deposits. Together these two layers range up to 41 feet (12.5 m) in thickness near the center of the plateau and pinch out along the northern, eastern, and southern edges of the plateau, where they have been truncated by the downward erosion of stream channels.

Depth to groundwater within the sand and gravel unit varies from 0 to 16 feet (0 to 5 m), being deepest generally beneath the central north plateau (beneath the main plant facilities) and intersecting the ground surface farther north toward the security fence.

Groundwater in this unit generally flows northeastward across the plateau towards Frank's Creek. Groundwater near the northwestern and southeastern margins of the sand and gravel layer also flows radially outward toward Quarry Creek and Erdman Brook, respectively. There is minimal groundwater flow downward into the underlying Lavery till. The mean hydraulic conductivity is 16.4 feet/day (6E-03 cm/sec) or 200 in/day, based on testing completed during the last several years.

Within the unweathered Lavery till on the north plateau is another unit, the Lavery till-sand. Onsite investigations from 1989 through 1990 identified this thin sandy unit of limited areal extent and variable thickness within the Lavery till, primarily beneath the southeastern portion of the north plateau. Groundwater flow through this unit is in an east-southeast direction. Surface discharge locations have not been observed. The mean hydraulic conductivity of 3.8 feet/day (1E-03 cm/sec) or 46 in/day for this unit is based on testing completed during the last several years.

Routine Groundwater Monitoring Program

The purpose of groundwater monitoring at the WVDP is to detect changes in groundwater quality within the five different hydrogeologic units previously described: the sand and gravel, the weathered Lavery till, the unweathered Lavery till, the Lavery till-sand, and the Kent recessional sequence. In 2001, a total of 65 groundwater monitoring locations were sampled. These locations included 59 monitoring wells (including driven well points), five groundwater seepage points, and one sump manhole.

Monitoring Well Network. Table E-1 (Appendix E [pp. E-3 through E-6]) lists the eleven super solid waste management units (SSWMUs) monitored by the well network, the hydraulic position of each well relative to the waste management unit, the geologic unit monitored, and the analytes measured in 2001. (See *super solid waste management unit* in the Glossary [p. GLO-10].) Note that monitoring of certain wells, marked by an asterisk, is required by the RCRA §3008(h) Administrative Order on Consent for the WVDP.

Figures A-7 and A-8 (pp. A-9 and A-10) show the boundaries of ten of the SSWMUs at the WVDP. (Twenty-one additional wells in an eleventh SSWMU monitor the SDA and are the responsibility of the New York State Energy Research and Development Authority [NYSERDA]. Locations of NYSERDA wells are shown on Fig. A-8 [p. A-10] in Appendix A. The SDA, a closed radioactive waste landfill, is contiguous with the Project premises, but the WVDP is not responsible for the facilities or activities relating to it. Under a joint agreement with the DOE, NYSERDA contracts with the Project to obtain specifically requested technical support in SDA-related matters. Groundwater monitoring results from the SDA are reported in this document in Appendix L [pp. L-3 through L-11] but are not discussed here.)

Table E-1 (pp. E-3 through E-6) identifies the hydraulic positions of monitoring locations relative to the SSWMUs. The wells monitoring a given hydrogeologic unit (e.g., sand and gravel, weathered Lavery till) also are arranged in a generalized upgradient to downgradient order based upon their location within the entire hydrogeologic unit. The hydraulic position of a well relative to a SSWMU (upgradient or downgradient) does not necessarily match that same well's position within its hydrogeologic unit. For example, a well that is upgradient in relation to a SSWMU may be located at any position within a hydrogeologic unit within the boundaries of the WVDP, depending on the geographic position of the SSWMU relative to the hydrogeologic unit. In general, the following text and graphics refer to the hydraulic position of monitoring wells within their respective hydrogeologic units, thus providing a site-wide perspective rather than a perspective centered on SSWMUs. Information provided in Appendix E (pp. E-7 through E-19) also follows this convention.

Potentiometric (water level) measurements also are collected from the wells listed in Table E-1 in conjunction with the quarterly analytical sampling schedule. (See Table 3-1 [p. 3-6].) Groundwater elevation data are used to produce groundwater contour maps, which delineate flow directions and gradients, and long-term trend graphs, which illustrate seasonal fluctuations and other changes in the groundwater system. In 2001, water levels were routinely measured at 42 locations in addition to those that were sampled.

Table 3-1
2001 Groundwater Sampling and Analysis Agenda

Analyte Group	*Description of Parameters[1]*	*Location of Sampling Results in Appendix E*
Contamination Indicator Parameters (I)	pH, specific conductance (field measurement)	Tables E-2 through E-8 (pp. E-7 through E-15)
Radiological Indicator Parameters (RI)	Gross alpha, gross beta, tritium	Tables E-2 through E-8 (pp. E-7 through E-15)
Volatile Organic Compounds (V)	NYCRR Appendix 33 Volatile Organic Compounds (VOCs) (See Table E-14 [p. E-20].)	Table E-9 (p. E-15)
Semivolatile Organic Compounds (SV)	NYCRR Appendix 33 Semi-volatile Organic Compounds (SVOCs) and tributyl phosphate (TBP) (See Table E-14 [p. E-20].)	Table E-10 (p. E-16)
NYCRR Appendix 33 Metals (M33)	Antimony, arsenic, barium, beryllium, cadmium, chromium, cobalt, copper, lead, mercury, nickel, selenium, silver, thallium, tin, vanadium, zinc	Table E-11 (pp. E-16 and E-17)
Special Monitoring Parameters for Early Warning Wells (SM)	Aluminum, iron, manganese	Table E-12 (p. E-17)
Radioisotopic Analyses: alpha-, beta-, and gamma-emitters (R)	C-14, Sr-90, Tc-99, I-129, Cs-137, Ra-226, Ra-228, U-232, U-233/234, U-235/236, U-238, total uranium	Table E-13 (pp. E-18 and E-19)
Strontium-90 (S)	Sr-90	Table E-13 (pp. E-18 and E-19)

2001 Quarterly Monitoring Schedule:
1st Qtr - December 1, 2000 to February 28, 2001
2nd Qtr - March 1, 2001 to May 31, 2001
3rd Qtr - June 1, 2001 to August 31, 2001
4th Qtr - September 1, 2001 to November 30, 2001

[1]Analysis completed for selected active monitoring locations only. See Table E-1 (pp. E-3 through E-6) for the analytes assigned to each monitoring location.

Groundwater Sampling Methodology

Groundwater samples are collected from monitoring wells using either dedicated Teflon® well bailers or bladder pumps. (Dedicated bailers are equipped with Teflon®-coated stainless steel leaders.)

The method of collection depends on well construction, water depth, and the water-yielding characteristics of the well. Bailers are used in low-yield wells; bladder pumps are used in wells with good water-yielding characteristics.

To ensure that only representative groundwater is sampled, three well volumes are removed (purged) from the well before the actual samples are collected. If three well volumes cannot be removed because of limited recharge, pumping or bailing the well to dryness provides sufficient purging. Conductivity and pH are measured before sampling and, if sufficient water is still available, after sampling to confirm the geochemical stability of the groundwater during sampling.

The bailer, a tube with a check valve at the bottom, is lowered into the well until it reaches the desired point in the water column. The bailer is lowered slowly to minimize agitation of the water column and is then withdrawn from the well with a sample and emptied into a sample container. The bailer, bailer line, and bottom-emptying device used to drain the bailer are dedicated to the well, that is, they are not used for any other well.

Bladder pumps use compressed air to gently squeeze a Teflon® bladder that is encased in a stainless steel tube located near the bottom of the well. When the pressure is released, new groundwater flows into the bladder. A series of check valves ensures that the water flows only in one direction. The operating air is always separated from the sample and is expelled to the surface by a separate line.

Bladder pumps reduce mixing and agitation of the water in the well. Each bladder pump system is dedicated to an individual well to reduce the likelihood of sample contamination from external materials or cross contamination. The air compressor and pump control box can be used from well to well because they do not contact the sample or the inside of the well.

Immediately after the samples are collected they are put into a cooler and returned to the Project's Environmental Laboratory. The samples are preserved with chemicals, if necessary, and stored under controlled conditions to minimize chemical and/or biological changes after sample collection. The samples are then either packaged for expedited delivery to an off-site contract laboratory or kept in controlled storage to await on-site testing. A strict chain-of-custody protocol is followed for all samples collected by the WVDP.

Surface water elevation measurements are also collected at eleven locations on the north plateau where the water table in the sand and gravel unit intersects the ground surface in the form of standing water. Surface water elevation measurements taken at these locations are correlated with groundwater elevation measurements taken at monitoring wells and are used routinely to help define groundwater flow-direction and gradients in the sand and gravel unit in areas where monitoring well coverage is sparse or nonexistent.

Groundwater Monitoring Program Highlights 1982 Through 2001. The groundwater monitoring program is designed to support DOE Order 5400.1 requirements and the RCRA §3008(h) Administrative Order on Consent for the WVDP. In general, the content of the program is dictated by these requirements in conjunction with current operating practices and historical knowledge of previous site activities.

• Groundwater monitoring at the WVDP began in 1982 with the monitoring of tritium in the sand and gravel unit in the area of the lagoon system.

• By 1984 twenty wells in the vicinity of the main plant and the NDA provided monitoring coverage.

• Fourteen new wells, a groundwater seep location, and the french drain outfall were added in 1986 to monitor additional site facilities.

• In 1990 ninety-six new wells were installed for data collection for the environmental impact statement and RCRA facility investigations.

• A RCRA facility investigation expanded-characterization program was conducted during 1993 and 1994 to fully assess potential releases of hazardous wastes or constituents from on-site SSWMUs. This investigation, which consisted of two rounds of sampling for a wide range of radiological and chemical parameters, provided valuable information regarding the presence or absence of groundwater contamination near each SSWMU and was also used to guide later monitoring program modifications.

• In 1993 monitoring results indicated elevated gross beta activity in groundwater in the sand and gravel unit on the north plateau. Subsequent investigation of this area delineated a plume of contamination with a southwest to northeast orientation. (See Special Groundwater Monitoring [p. 3-15] for more detail.)

• Long-term monitoring needs were the focus of a 1995 groundwater monitoring program evaluation. After a comprehensive assessment, the number of sampling locations was reduced from ninety-one to sixty-five and analytical parameters were tailored for each sampling location, for a more focused, efficient, and cost-effective program.

• In 1996 several groundwater seep monitoring locations on the northeast edge of the north plateau were added to the monitoring program.

• From 1996 through 2001, in response to current sampling results and DOE and RCRA monitoring requirements, wells to be monitored, analytes, and sampling frequencies were modified.

Annual Analytical Trigger Level Review. A computerized data-evaluation program using “trigger levels” for chemical and radiological analytes was instituted in 1995. These pre-set levels – conservative values for chemical or radiological concentrations – were developed to identify and expedite a prompt focus on any anomalies in monitoring results. These values are based on regulatory limits, detection limits, or statistically derived levels. Trigger levels are reviewed and updated every year, if necessary, using all pre-existing data as well as the current year’s data. The trigger levels were updated before the start of the first-quarter 2001 groundwater monitoring.

Upper and lower trigger levels for groundwater elevation measurements were introduced in 1999. These levels are used to identify field measurement anomalies, allowing prompt investigation and remeasurement, if necessary. Groundwater-elevation trigger levels were updated before the start of the first-quarter 2001 groundwater monitoring.

Results of Routine Groundwater Monitoring

Each component of the groundwater monitoring program is completed in accordance with regulatory protocols. These components include locating and installing wells, collecting groundwater samples, incorporating quality assurance methods, and evaluating data.

The tables in Appendix E (pp. E-7 through E-19) group the results of groundwater monitoring according to the five hydrogeologic units monitored: the sand and gravel unit, the Lavery till-sand unit, the weathered Lavery till unit, the unweathered Lavery till unit, and the Kent recessional sequence. These tables contain the results of sampling for the radiological and nonradiological analyte groups noted on Table 3-1 (p. 3-6). In addition, Table E-14 (pp. E-20 through E-22) lists the practical quantitation limits (PQLs) for individual New York Official Compilation of Codes, Rules, and Regulations (NYCRR) Title 6, Appendix 33 analytes. (The PQL is the lowest level of an analyte that can be measured within specified limits of precision during routine laboratory operations [New York State Department of Environmental Conservation, 1991].)

Appendix E tables also provide each well's hydraulic position relative to other wells within the same hydrogeologic unit. Wells identified as UP refer to either background wells or wells that are upgradient of other wells in the same hydrogeologic unit. Wells identified as DOWN are downgradient of other wells in that unit. In each table wells are presented from upgradient to furthest downgradient. Grouping the wells by hydraulic position provides the basis for presenting the groundwater monitoring data in the tables and figures in this report. (See Table 3-1 [p. 3-6] for the quarterly groundwater monitoring schedule.)

Using a Datalogger to Record Hydraulic Conductivity Data From an On-Site Monitoring Well

High-Low graphs. Graphs showing the range of values for contamination and radiological indicator parameters (pH, conductivity, gross alpha, gross beta, and tritium) have been prepared for all active monitoring locations in each geologic unit. (See Appendix E [pp. E-24 through E-32].) These high-low graphs allow results for all wells within a given hydrogeologic unit to be compared to each other. All of the high-low graphs present the upgradient wells on the left side of the figure. Downgradient locations are plotted to the right according to their relative position along the groundwater flow path.

On the high-low graphs depicting nonradiological contamination indicator results (pH and conductivity), the upper and lower tick marks on the vertical bar indicate the highest and lowest measurements recorded during 2001 for a particular well. The middle tick represents the arithmetic mean of all 2001 results for that well. The vertical bar indicates the total range of the data set for each monitoring location during the year.

On the high-low graphs depicting radiological indicator results (gross alpha, gross beta, and tritium), the middle tick is again used to represent the arithmetic mean of all 2001 results. However, the upper and lower tick marks on the vertical bar indicate the upper and lower ranges of the pooled error terms for all 2001 results. This format illustrates the relative amount of uncertainty associated with the radiological measurements. By displaying the uncertainty together with the mean, a more realistic perspective is obtained. (See also Data Reporting [p. 1-4] in Chapter 1, Environmental Program Information.) On magnified-scale graphs, markers for some locations cannot be shown because the magnitude of the concentration is larger than the upper range of the graph.

The analytical results for gross alpha, gross beta, and tritium, even if below the minimum detectable concentrations, were used to generate the high-low graphs. Thus, negative values were included. This is most common for the gross alpha analyses, where sample radiological counting results may be lower than the associated background.

The wells used to provide background values are noted on each graph. All of the geologic units except the sand and gravel unit use a single well for background. In previous years well NB1S was used as the single background reference well for the sand and gravel unit. However, in 1997 the collective monitoring results from three upgradient wells (301, 401, and 706) were substituted for NB1S to use for comparison with other sand and gravel wells as a way of better representing the natural spatial variability within this geologic unit. Both the DOE and the New York State Department of Environmental Conservation (NYSDEC) have accepted the use of this collective background reference instead of well NB1S.

Trend-Line graphs. Trend-line graphs have been used at monitoring locations that have historically shown radiological concentrations above background values for volatile and semivolatile organic compound (VOC or SVOC) concentrations above practical quantitation limits. Graphs are included for gross beta and tritium at selected groundwater monitoring locations (104, 105, 111, 408, 501, 502, 801, 8603, 8604, and 8605) and for the VOCs 1,1-dichloroethane (1,1-DCA) at wells 803, 8609, and 8612; dichlorodifluoromethane (DCDFMeth) at wells 803 and 8612;1,2-dichloroethylene (1,2-DCE-t) and 1,1,1-trichloroethane (1,1,1-TCA) at well 8612; and tributyl phosphate (TBP) at wells 111 and 8605. (See Volatile and Semivolatile Organic Compounds Sampling [p. 3-14].)

Long-Term Trends of Gross Beta and Tritium at Selected Groundwater Monitoring Locations. Figures 3-5 through 3-10 (pp. 3-18 through 3-20) show the trends of gross beta and tritium concentrations at selected monitoring locations in the sand and gravel unit. These specific groundwater monitoring locations were selected for trending because they have shown elevated or rising levels of gross beta concentrations, with some also showing elevated levels of tritium. Results are presented on a logarithmic scale to allow locations having widely differing concentrations to be compared to the average background concentrations plotted on each graph.

Gross Beta. The groundwater plume of gross beta activity in the sand and gravel unit on the north plateau (Fig. 3-3 [p. 3-12]) continues to be monitored closely. The source of the plume's activity can be traced to the subsurface beneath the southwest corner of the former process building. In 2001, ten wells (104, 105, 111, 408, 501, 502, 801, 8603, 8604, and 8605) showed gross beta concentrations that exceeded the DOE derived concentration guide (DCG) for strontium-90 (1.0E-06 µCi/mL). Lagoon 1, formerly part of the low-level waste treatment facility, has been identified as a source of the gross beta activity at wells 8605 and 111. The gross beta concentrations at well 8605 have been slowly but steadily decreasing over the past several years while concentrations at 111 continued to fluctuate within historical levels. Contamination observed at SP11 is believed to be attributable to re-infiltration of contaminated water that has surfaced from the strontium-90 groundwater plume.

• Figures 3-5 and 3-6 (p. 3-18) show gross beta concentrations in wells 104, 105, 111, 408, 501, 502, and 801 over the last eleven years. As in previous years, samples from well 408 continued to show the highest gross beta concentrations of all the wells within the north plateau gross beta plume area. Gross beta results for well 408 were slightly higher in 2001 than in 2000.

Gross beta at well 111 was slightly higher in 2001 than in 2000. Wells 501, 502, and 801 showed slight increases relative to 2000, and wells 104 and 105 showed somewhat greater increases relative to 2000 values.

• Figure 3-7 (p. 3-19) is a graph of gross beta concentrations at sand and gravel unit monitoring locations 8603, 8604, and 8605. After several years of increases in gross beta concentrations in well 8604, the trend showed relatively minor fluctuations during 1996 through 2001. Results from well 8603 showed a steady upward trend until early 2000, with only slight fluctuations since then.

Tritium. Tritium in sand and gravel wells also is routinely monitored as part of the groundwater program.

• Figure 3-8 (p. 3-19) shows the tritium concentrations in wells 111, 408, 501, and 502 over the eleven-year period that the WVDP's current groundwater monitoring program has been in place. The figure indicates that tritium concentrations in these wells show slight decreases or relatively consistent trends.

• Figure 3-9 (p. 3-20) shows tritium concentrations in wells 104, 105 and 801 over the past eleven years. Well 801 shows a general decrease until 2000 and a slight increase for 2001; wells 104 and 105 show a slight decrease over the past two to three years.

• Figure 3-10 (p. 3-20) shows sixteen-year trends of tritium concentrations at monitoring locations 8603, 8604, and 8605. Wells 8603 and 8604 indicate gradually declining trends in tritium; 8605 shows a significant decrease over time.

North Plateau Seeps. Analytical results of sampling for radiological parameters from the sand and gravel unit seepage monitoring locations were compared with the results from GSEEP, a seep monitored since 1991 that has not been affected by the gross beta plume. (Seep monitoring locations are noted on Figs. A-6 and A-7 [pp. A-8 and A-9].)

Gross Beta. Radiological monitoring results continue to indicate that the gross beta groundwater plume has not migrated to these seepage areas. With the exception of SP11, gross beta concen-

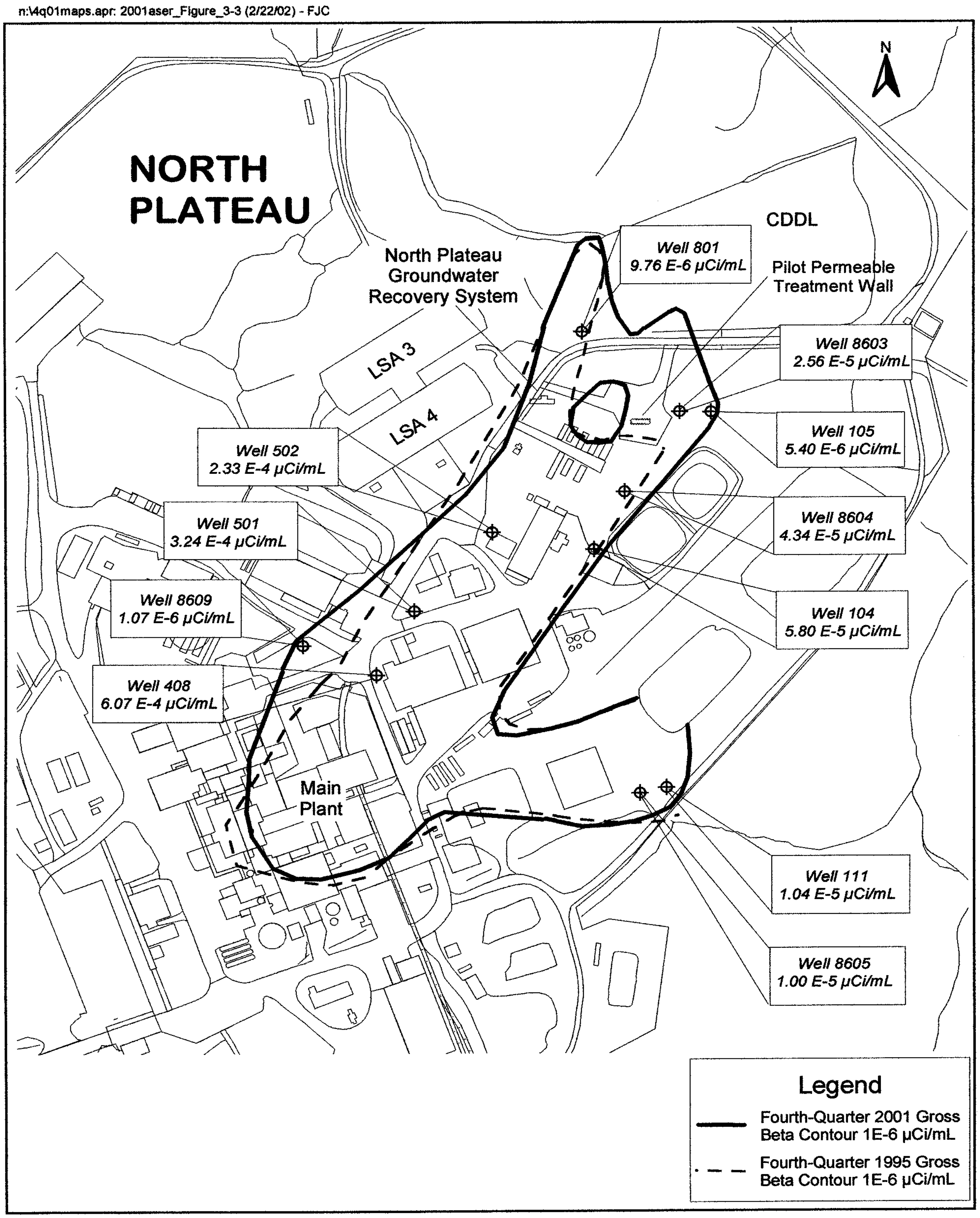

Figure 3-3. North Plateau Gross Beta Plume Area: Fourth-Quarter 2001 Results

trations from all seep monitoring locations were less than or similar to GSEEP concentrations during 2001. The gross beta concentration at SP11 shows a slightly increasing trend since early 1999 and somewhat steeper increases during the second half of 2001. Although somewhat greater than values typically obtained at GSEEP, it is still well below the strontium-90 DCG. (See Table E-7 [p. E-14].)

Gross Alpha. Gross alpha concentrations at all of the seep sampling locations were very low – generally below the associated uncertainty or less than the detection limit.

Tritium. Tritium concentrations at the seeps remained similar in magnitude or were less than concentrations at GSEEP. Tritium concentrations in the north plateau seeps, including GSEEP, are slightly above the levels reported in background wells of the sand and gravel unit. The concentrations are similar to those seen in sand and gravel unit wells monitoring the lagoon areas of the north plateau but are still far below the DCG for tritium.

The north plateau seep monitoring locations are inspected periodically and repaired as necessary to maintain optimum seepage flow. This ensures the quality, quantity, and representativeness of the groundwater samples. The conditions at all seep monitoring locations are checked during routine sampling and during the annual inspection of groundwater monitoring equipment.

North Plateau Well Points. Seven well points were installed in 1990 downgradient of the process building and were sampled annually between 1993 and 1996 for radiological indicator parameters. This area east of the process building and west of inactive lagoon 1 appears to be an area of localized contamination and is routinely monitored for contamination indicator and radiological indicator parameters. Data from these seven well points were used to supplement data collected from groundwater monitoring wells. Four well points were removed from the sampling program in 1997 because sufficient coverage was provided by active monitoring wells.

Sampling at well points A, C, and H (Fig. A-6 [p. A-8]) monitors tritium concentrations in the area east of the process building and fuel receiving and storage facility (FRS) and west of inactive lagoon 1. Samples from these three locations have yielded concentrations of tritium that, while elevated with respect to historical monitoring of wells in the area, are well below the DCG of 2.0E-03 µCi/mL. (See Table E-8 [p. E-15].) Data from downgradient monitoring wells have not indicated similarly elevated levels of tritium.

Results of Radioisotopic Sampling. Groundwater samples for radioisotopic analyses are collected regularly from selected monitoring points in the sand and gravel unit and the weathered Lavery till. (See Table E-13 [pp. E-18 and E-19].) Results in 2001 were generally similar to historical findings. Strontium-90 remained the major contributor to elevated gross beta activity in the plume on the north plateau, as indicated by the similarity between strontium-90 trends and gross beta trends in wells showing elevated gross beta results.

Carbon-14, technetium-99, and iodine-129, which have been detected at several monitoring locations at concentrations above background levels, contribute very small percentages to total gross beta concentrations. These detections have occurred at locations within the gross beta plume and downgradient of inactive lagoon 1 and the NDA. None of the concentrations of carbon-14, technetium-99 or iodine-129 have been above DCGs, and gross beta analyses continue to provide surveillance on a quarterly basis.

Results of Monitoring at the NDA. A trench system was constructed along the northeast and northwest sides of the NDA to collect groundwater that may be contaminated with a mixture of n-dodecane and tributyl phosphate. (See also Chapter 1, Environmental Program Information, NRC-Licensed Disposal Area [NDA] Interceptor Trench and Pretreatment System [p. 1-11].) There were no monitoring results in 2001 that indicated the presence of TBP or n-dodecane in groundwater in the vicinity of the NDA. Groundwater levels are monitored quarterly in and around the trench to ensure that an inward gradient is maintained, thereby minimizing the likelihood for outward migration of potentially contaminated groundwater.

Gross beta and tritium concentrations in samples from location NDATR, a sump at the lowest point of the interceptor trench, and from well 909 (Fig. A-6 [p. A-8]), which is downgradient of NDATR, continued to be elevated with respect to background monitoring locations on the south plateau but were still well below the DCGs.

NDATR. During 2001 gross beta concentrations at NDATR were slightly higher than those seen during 2000, but tritium, while still higher than at other NDA monitoring locations, declined and then leveled off during recent years.

Well 909. Radiological indicator results have historically fluctuated at this location but, in general, upward long-term trends in both gross beta and tritium are discernible at well 909, although the trends show a decrease and then a leveling off during 2000 and 2001. Gross beta concentrations from well 909 are considerably higher than at NDATR. Residual soil contamination near well 909 is the suspected source of elevated gross beta concentrations at well 909.

Volatile and Semivolatile Organic Compounds Sampling

Volatile and semivolatile organic compounds were sampled at specific locations (wells 8612, 8609, 803, and seep sampling location SP12 [Fig. A-6, p. A-8]) that have shown historical results above their respective practical quantitation limits. (See Table E-14 [pp. E-20 through E-22] for a list of PQLs.) Other monitoring locations are sampled for volatile and/or semivolatile organic compounds because they are downgradient of locations that have shown positive results or to comply with the RCRA §3008(h) Administrative Order on Consent.

1,1-Dichloroethane. Trends in concentrations of the compound 1,1-DCA from 1991 through 2001 are illustrated in Figure 3-11 (p. 3-21). Concentrations of 1,1-DCA at well 8612 have decreased over the past six years. The compound was not detected at wells 8609, 803, or groundwater seep SP12 during 2001. (See Table E-9 [p. E-15].)

Dichlorodifluoromethane. Trends of DCDFMeth concentrations are shown in Figure 3-12 (p. 3-21). DCDFMeth was detected at wells 803 and 8612 during 2001 at levels below the PQL.

1,2-Dichloroethylene. Positive detections of 1,2-DCE-t were first noticed at well 8612 (Fig. 3-13 [p. 3-22]) in 1995. Concentrations of 1,2-DCE-t during 2001 were slightly higher than those measured during 2000.

1,1,1-Trichloroethane. The compound 1,1,1-TCA was detected in wells 8609 and 8612 during 2001 at levels below the PQL but was not detected in well 803 or in seep SP12. (See Table E-9 [p. E-15] for a summary of concentrations at these locations and Fig. 3-13 [p. 3-22] for a graph of 1,1,1-TCA concentrations at well 8612.)

The VOCs 1,1-DCA, DCDFMeth, and 1,1,1-TCA are often found in combination with each other and with 1,2-DCE-t. In well 8612 each of these three compounds first exhibited an increasing trend that, over the past few years, was then followed by a decreasing trend. It is expected that 1,2-DCE-t will exhibit similar behavior, and routine monitoring will evaluate future trends.

Tributyl Phosphate. Concentrations of tributyl phosphate were detected in 2001 groundwater samples from well 8605, near former lagoon 1, at concentrations similar to or less than those in 2000. TBP also was detected in well 111, which is next to and downgradient of well 8605, but at levels much lower than those at well 8605. (See Fig. 3-14 [p. 3-22] and Table E-10 [p. E-16].)

The ongoing detection of TBP in this localized area may be related to previously detected low, positive concentrations of iodine-129 and uranium-232 in wells 111 and 8605, as noted in previous annual site environmental reports. The presence of these three contaminants may reflect residual contamination from liquid waste management activities in the former lagoon 1 area during earlier nuclear fuel reprocessing. Future trends of TBP will be evaluated as part of the routine groundwater monitoring program.

Special Groundwater Monitoring

Gross Beta Plume on the North Plateau. Elevated gross beta activity has been detected in groundwater from the surficial sand and gravel unit in areas north and east of the building where Nuclear Fuel Services, Inc. (NFS) reprocessed nuclear fuel (Fig. 3-3 [p. 3-12]). In December 1993 elevated gross beta concentrations were detected in surface water at former sampling location WNDMPNE, located near the edge of the plateau. This detection initiated a subsurface investigation in 1994. Groundwater and soil were sampled using a Geoprobe®, a mobile sampling system. The investigation was used to estimate the extent of the gross beta plume beneath and downgradient of the process building. The gross beta plume delineated in 1994 was approximately 300 feet wide and 800 feet long.

The highest gross beta concentrations in groundwater and soil were near the southeast corner of the process building. For the 1994 study, the maximum concentration in groundwater was 3.6E-03 µCi/mL, and the maximum concentration in soil was 2.4E-02 µCi/g. Strontium-90 and its daughter product, yttrium-90, were determined to be the isotopes responsible for most of this elevated gross beta activity (West Valley Nuclear Services Co., Inc., 1995).

In 1995 the north plateau groundwater recovery system (NPGRS) was installed to minimize the advance of the gross beta plume. The NPGRS is located near the leading edge of the main lobe of the plume where groundwater flows preferentially towards the edge of the plateau. The NPGRS consists of three extraction wells (RW-01, RW-02, and RW-03) that recover the contaminated groundwater which is then treated by ion exchange to remove strontium-90. Treated water is transferred to lagoon 4 or 5, then to lagoon 3, and ultimately is discharged to Erdman Brook.

The north plateau groundwater recovery system operated successfully throughout 2001, processing about 3.4 million gallons (13 million liters). The system has recovered and processed approximately 25 million gallons (96 million liters) since November 1995.

As a result of recommendations from a 1997 external review of WVDP response actions on the north plateau, more attention was given in 1998 to the core area of the plume, determined to be beneath and immediately downgradient of the former process building. A summary report, 1998

Geoprobe® Investigation in the Core Area of the North Plateau Groundwater Plume (West Valley Nuclear Services Co., Inc., June 1999) discusses groundwater and soil sampling data in the core area and compares radiological sampling results with the 1994 data. The 1998 study verified that strontium-90 is the predominant beta-emitter in groundwater and saturated soil within the north plateau groundwater plume. The report also noted that while the overall distribution of strontium-90 in groundwater within the plume was similar to 1994, concentrations detected in 1998 samples were generally lower than in the 1994 samples due to radioactive decay and continuing migration and dispersion of the plume.

Permeable Treatment Wall. A pilot-scale permeable treatment wall (PTW) was completed in the fall of 1999 in the eastern lobe of the north plateau strontium-90 groundwater plume in order to test this passive, in situ remediation technology. The PTW is a trench constructed in the subsurface and backfilled with clinoptilolite, a medium selected for its ability to adsorb strontium-90 ions from groundwater. The PTW extends vertically downward through the sand and gravel unit to the top of the underlying Lavery till and is approximately 30 feet long and 10 feet wide.

Monitoring and evaluation of water levels and radiological concentrations upgradient, within, and downgradient of the PTW continued during 2001 in order to assess its effectiveness. Additional test borings and monitoring well installations were completed in the vicinity of the PTW during the fall of 2001 in order to obtain improved definition of hydrogeologic conditions. Hydraulic testing in the new wells is planned for early 2002. These new data will be used to evaluate the performance of the pilot PTW.

Northeast Swamp Drainage Monitoring. Routine surface water sampling during 2001 continued to monitor radioactivity levels in surface water flowing through the outlet location WNSWAMP. (See Appendix C, Table C-7 [p. C-8].) Gross beta and strontium-90 concentrations continued to fluctuate due to seasonal effects. The annualized average strontium-90 concentrations were consistent for the first five months and then steadily increased during the remainder of the year. (See Fig. 3-4 [p. 3-17].) The increase is believed to be due to a natural concentrating effect resulting from below-average precipitation during the summer and fall months. (See Figures I-4 and I-5 [p. I-6] and Table I-1 [p. I-7] in Appendix I.)

Although the annualized averaged concentration of strontium-90 in surface water increased at sampling location WNSWAMP (on the WVDP premises), monitoring downstream at the first point of public access (WFFELBR) continued to show strontium-90 concentrations that were not significantly different from background (WFBIGBR) concentrations. (See also Northeast Swamp and North Swamp Sampling Locations [p. 2-4] in Chapter 2, Environmental Monitoring.)

North Plateau Groundwater Quality Early Warning Monitoring. This monitoring is important because water recovered by the NPGRS ultimately is discharged through outfall 001. Quarterly monitoring results from three wells (116, 602A, and 502) in the vicinity of the NPGRS are assigned to identify concentrations that may affect compliance with SPDES effluent limits. Routine results for two of the wells, 116 and 602A, are used to monitor groundwater in the area affected by NPGRS drawdown. The third well, 502, is directly upgradient of the NPGRS and is sampled for additional metals not routinely analyzed under the current groundwater monitoring program. Analytical results of sampling of well 502 for additional metals can be found in Table E-12 (p. E-17 in Appendix E).

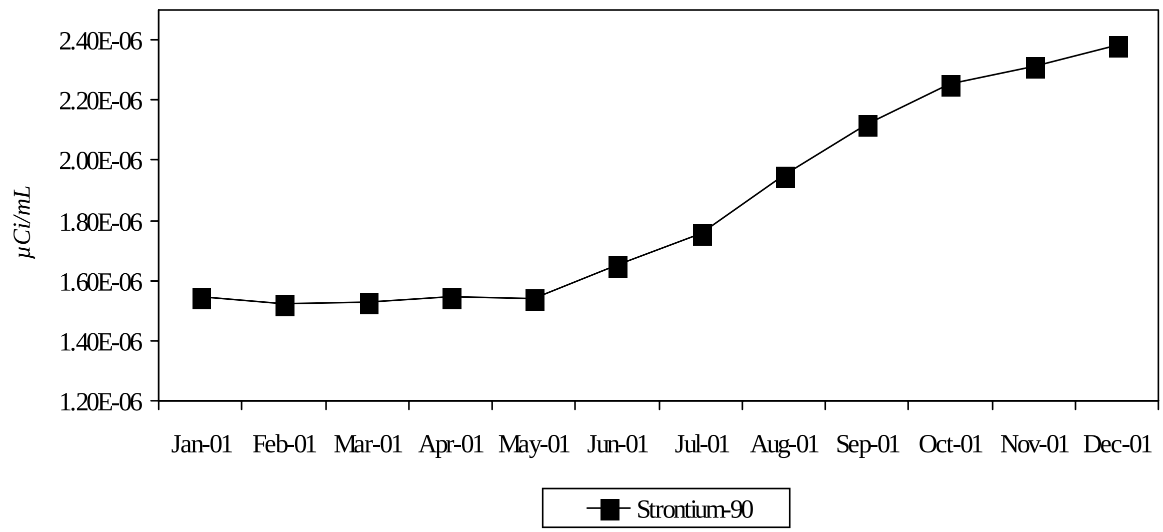

Figure 3-4. Annualized Average Strontium-90 Concentrations at WNSWAMP

Investigation of Chromium and Nickel in the Sand and Gravel Unit and Evaluation of Corrosion in Groundwater Monitoring Wells. A 1997 and 1998 study of the effect of modifying sampling equipment and methodology on the concentrations of chromium and nickel in samples of groundwater from the sand and gravel unit noted that such modifications did produce decreases in chromium and nickel concentrations. This supported the hypothesis (which is well documented in the technical literature) that the apparently elevated concentrations were not representative of actual groundwater conditions but were caused by the release of metals from subsurface corrosion of stainless steel well materials (West Valley Nuclear Services, Inc. and Dames & Moore, June 1998).

To ensure continued monitoring well integrity and the collection of high-quality samples representative of actual groundwater conditions, approximately three-fourths of the stainless steel wells monitoring the sand and gravel unit were internally inspected for corrosion during 2001. Wells containing corrosion were cleaned using simple brushing and purging techniques. Cleaned wells were reinspected to verify that corrosion had been removed. Long-term corrosion management will include annual inspections of selected wells.

Ten-Year Sampling Pump Inspections. Dedicated bladder pumps were installed in many WVDP monitoring wells in 1991. (See Groundwater Sampling Methodology [p. 3-7].) Pumps in all actively sampled wells were removed and inspected during 2001 in order to evaluate conditions after ten years of use. All pumps were found to be in good, serviceable condition and future maintenance will be based on observations made during routine quarterly sampling activities.

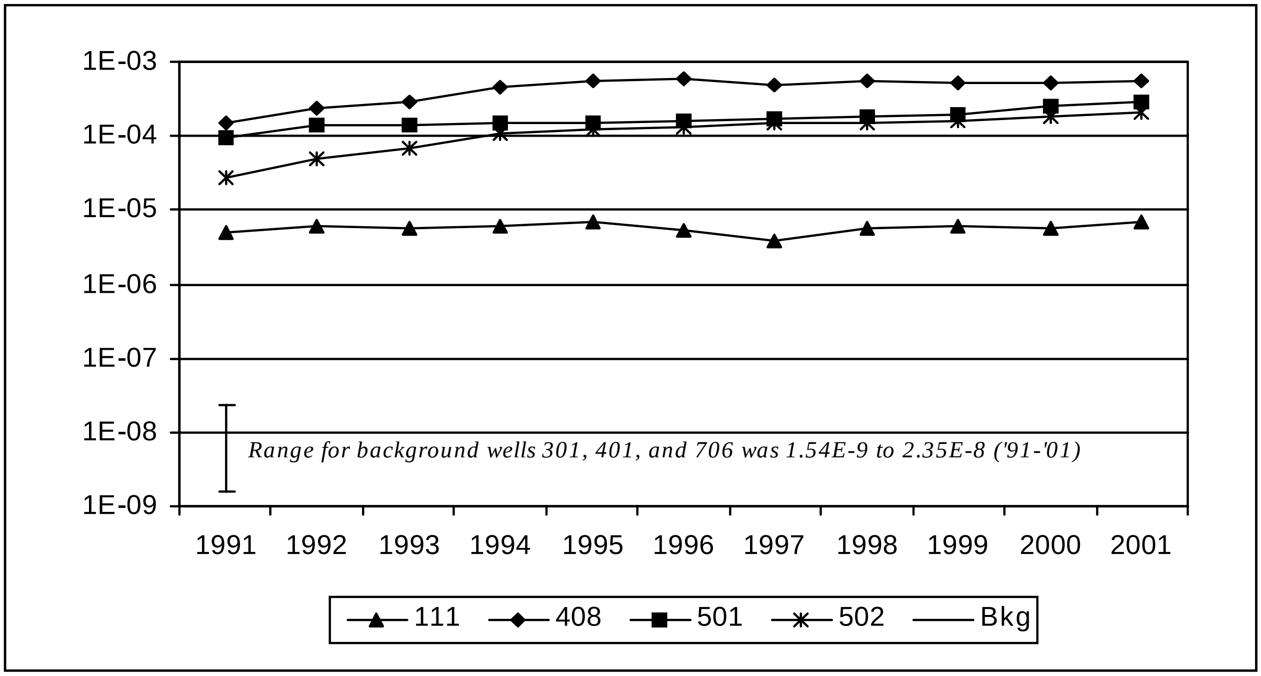

Figure 3-5. Eleven-Year Trends of Averaged Gross Beta Concentrations (µCi/mL) at Selected Locations in the Sand and Gravel Unit

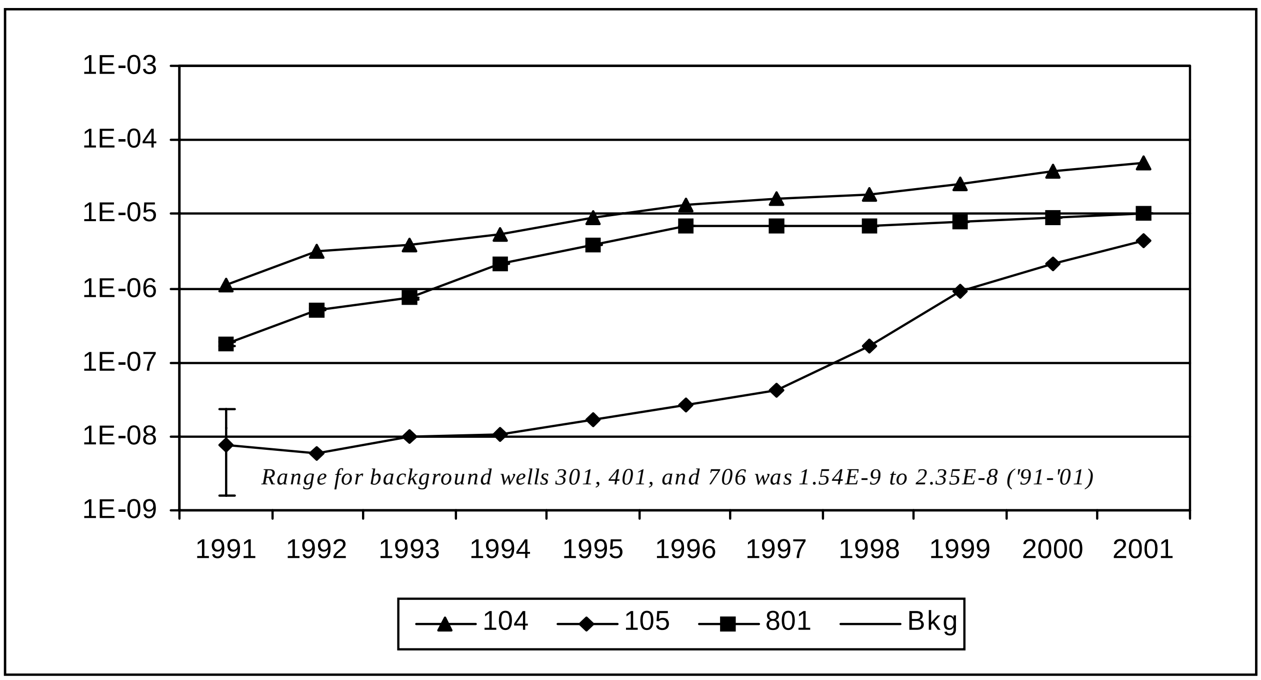

Figure 3-6. Eleven-Year Trends of Averaged Gross Beta Concentrations (µCi/mL) at Selected Locations in the Sand and Gravel Unit

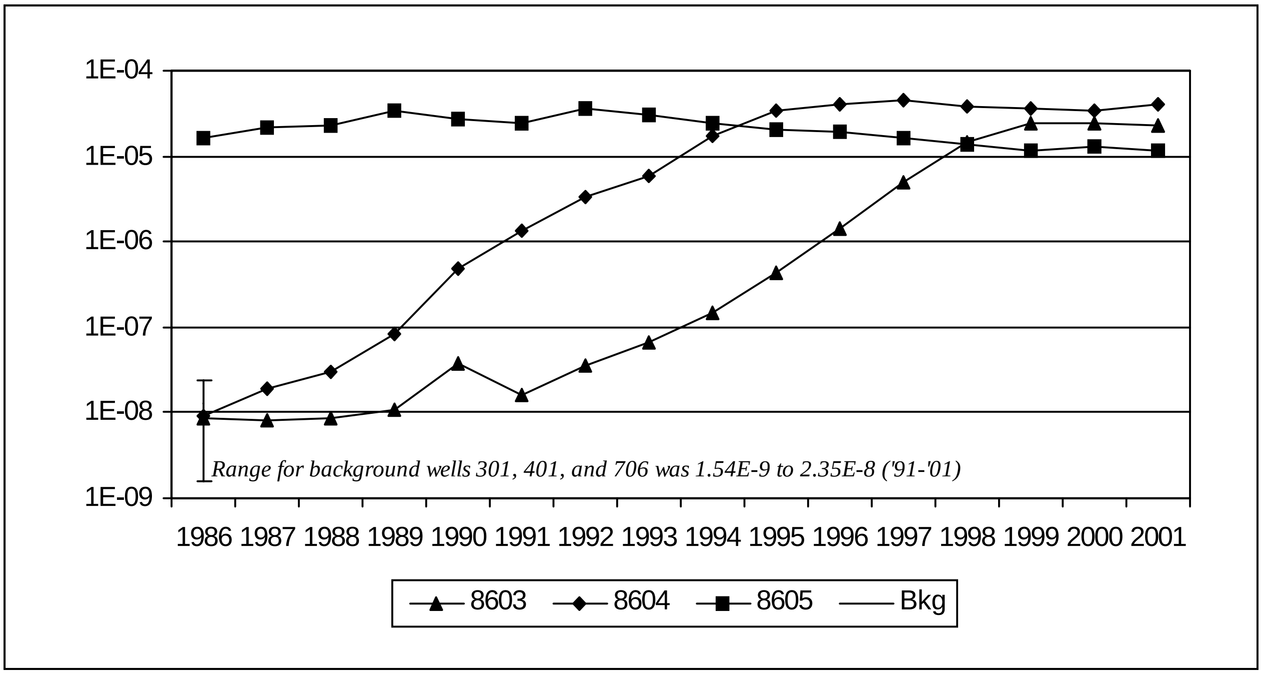

Figure 3-7. Sixteen-Year Trends of Averaged Gross Beta Concentrations (µCi/mL) at Selected Locations in the Sand and Gravel Unit

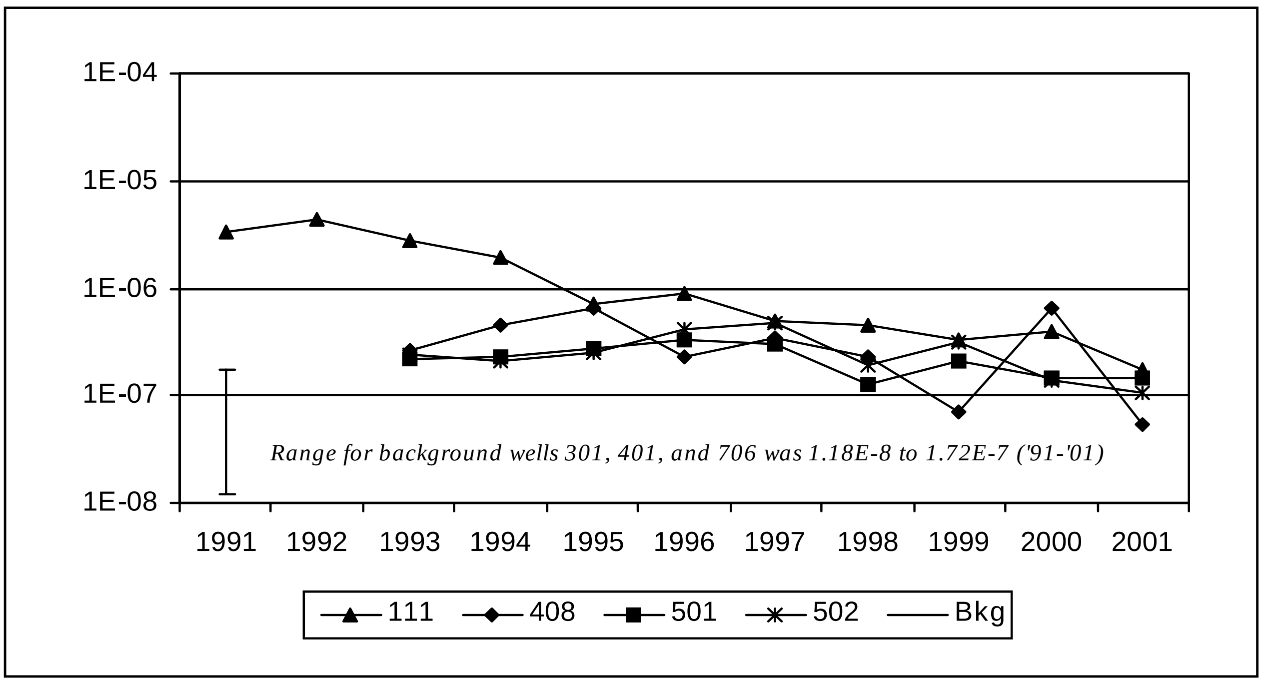

Figure 3-8. Eleven-Year Trends of Averaged Tritium Concentrations (µCi/mL) at Selected Locations in the Sand and Gravel Unit

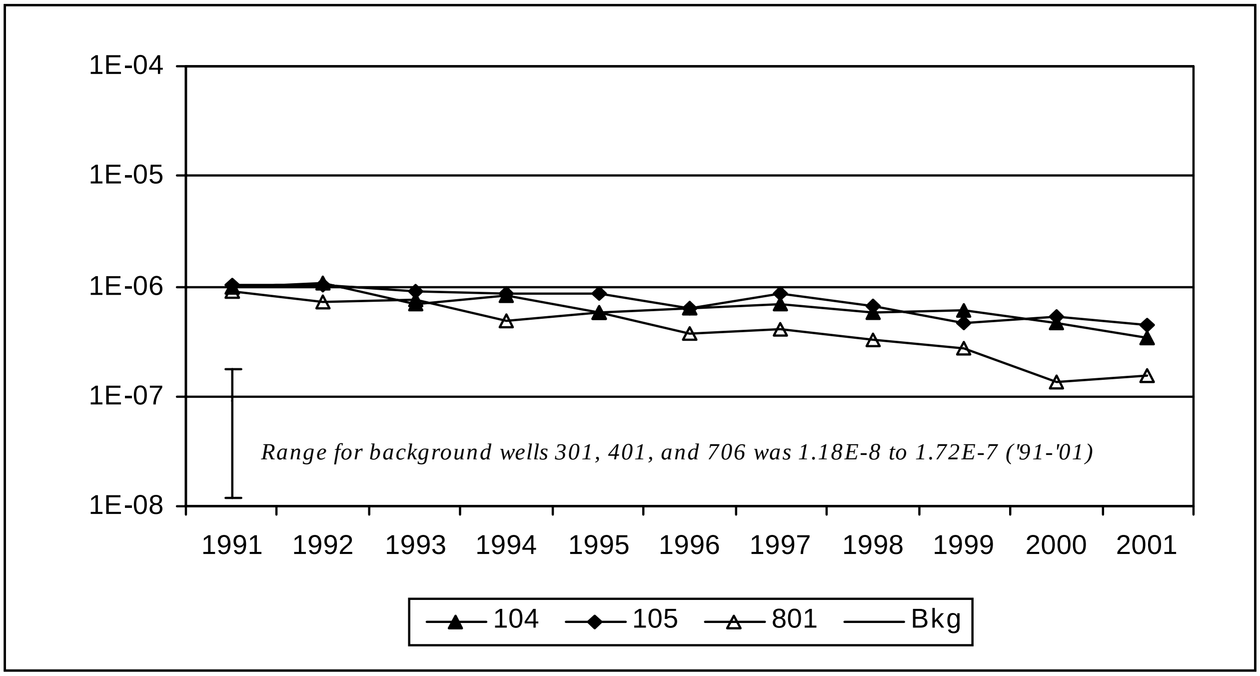

Figure 3-9. Eleven-Year Trends of Averaged Tritium Concentrations (µCi/mL) at Selected Locations in the Sand and Gravel Unit

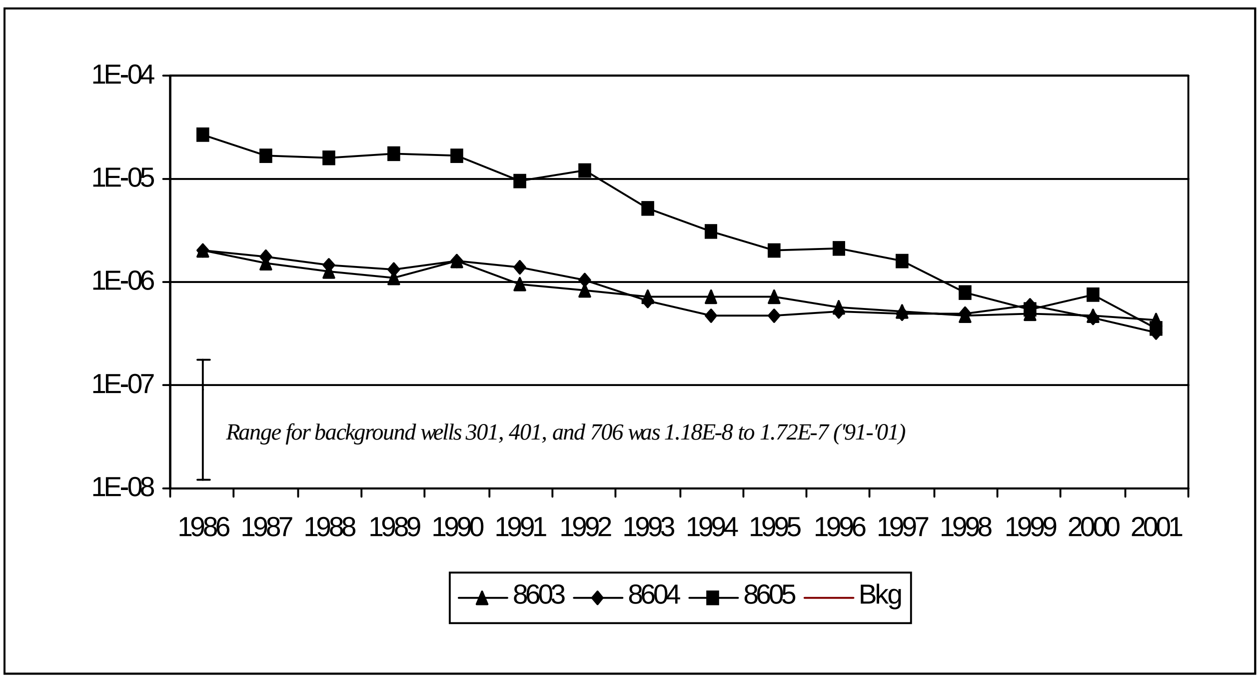

Figure 3-10. Sixteen-Year Trends of Averaged Tritium Concentrations (µCi/mL) at Selected Locations in the Sand and Gravel Unit

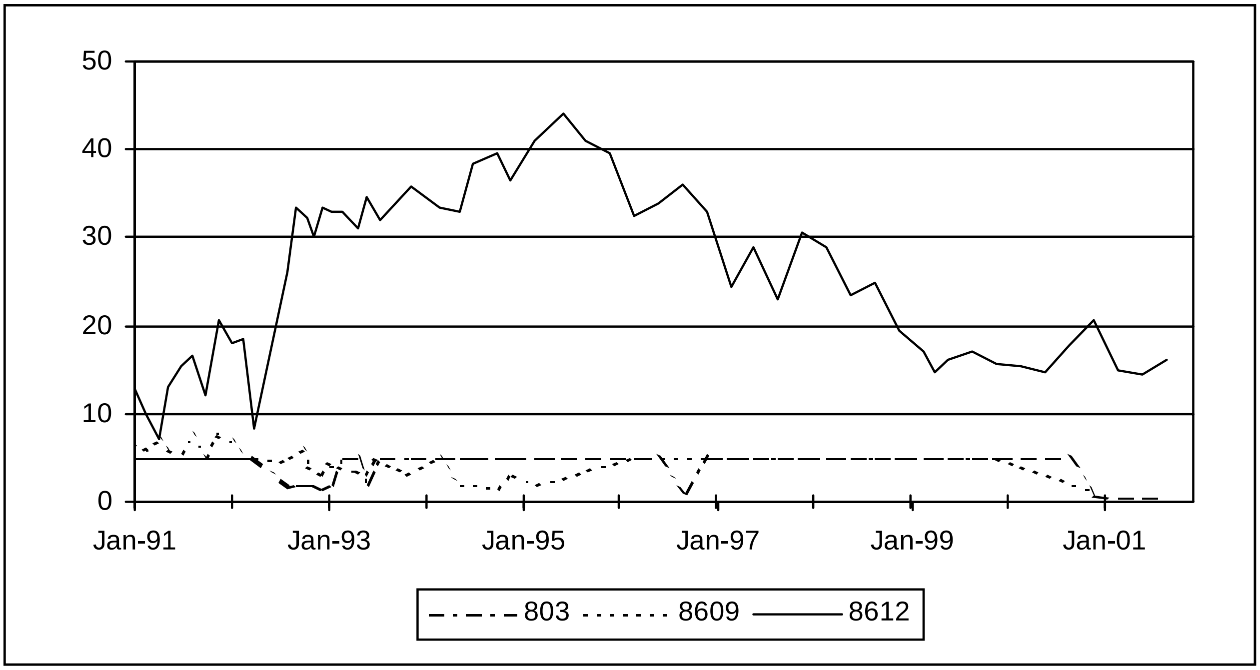

Figure 3-11. Eleven-Year Trends of 1,1-DCA (µg/L) at Selected Locations in the Sand and Gravel Unit

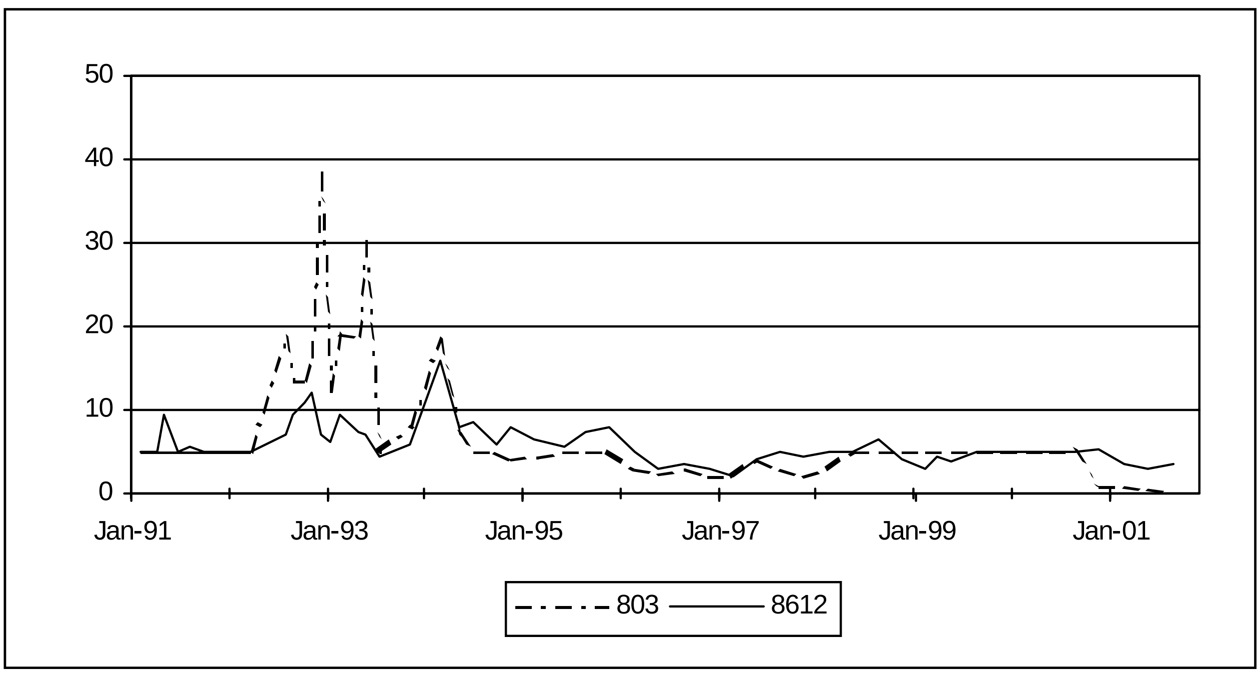

Figure 3-12. Eleven-Year Trends of Dichlorodifluoromethane (µg/L) at Selected Locations in the Sand and Gravel Unit

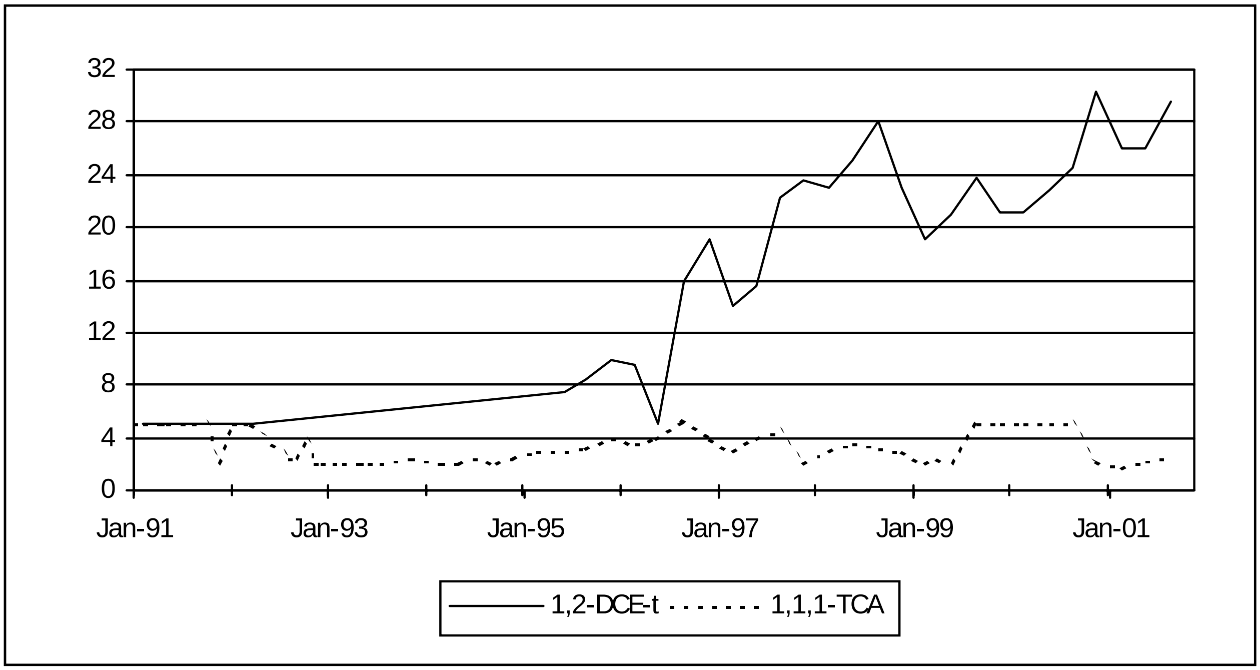

Figure 3-13. Eleven-Year Trends of 1,2-DCE-t and 1,1,1-TCA (µg/L) at Well 8612 in the Sand and Gravel Unit

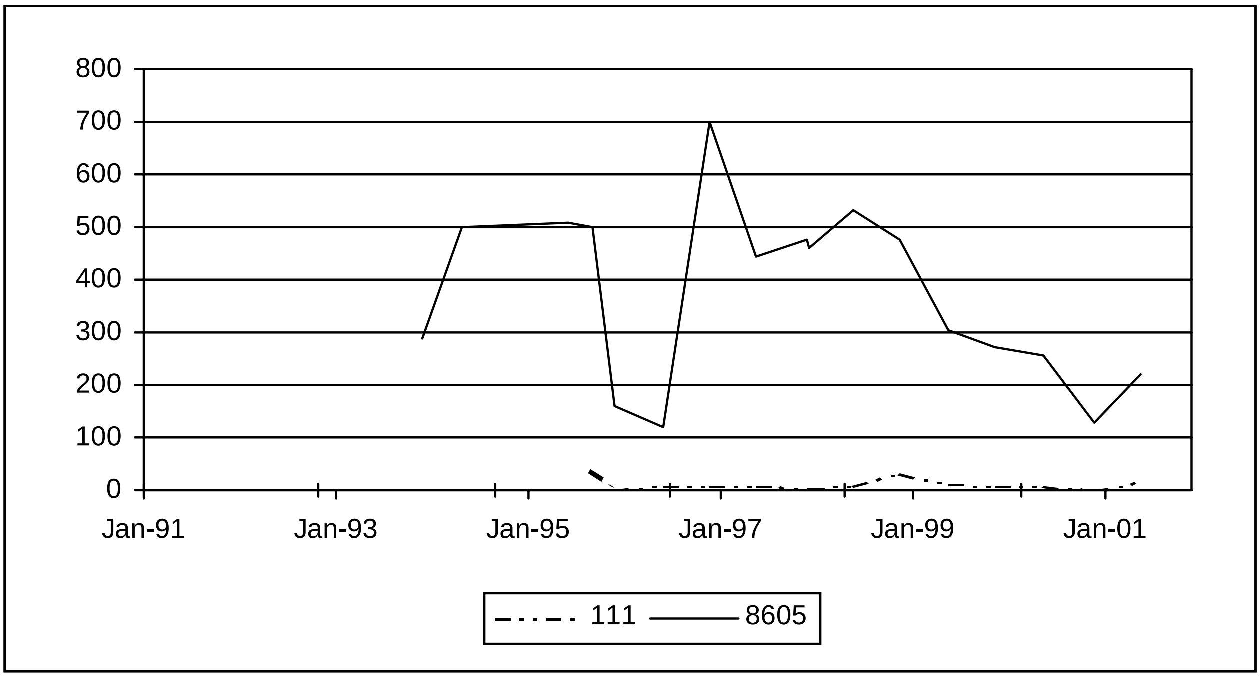

Figure 3-14. Trends of Tributyl Phosphate (µg/L) at Selected Locations in the Sand and Gravel Unit